

# KOREA

## ABSTRACT

The Korea ICAP work applies a bottom-up impact analysis approach to evaluate the ancillary benefits resulting from greenhouse gas mitigation policies and measures. This work initially has focused on the impact of these greenhouse gas mitigation measures on PM10 levels in the Seoul Metropolitan area and the corresponding impact on premature mortality and morbidity of asthma and respiratory diseases in 1995 through 2020. The greenhouse gas scenarios considered in this preliminary analysis focus primarily on energy efficiency and use of compressed natural gas for vehicles. More aggressive greenhouse gas reduction scenarios that include fuel substitution outside of the transportation sector would likely generate greater air pollution health benefits.

The preliminary results reveal that modest greenhouse gas reduction scenarios (5-15% reductions in 2020) can result in significant air pollution health benefits through reductions in PM10 concentrations. For instance, these greenhouse gas reduction measures for Korea's energy sector could avoid 40 to 120 premature deaths/yr. and 2800 to 8300 cases/yr. of asthma and other respiratory diseases in the Seoul Metropolitan Area in 2020. The cumulative value of these avoided health effects is estimated to range from 10 to 125 million US\$/yr (in 1999 dollars with annual discounting rate 0.75%). This is equivalent to a benefit of \$10 to \$42 per ton of carbon emissions reduced in 2020 for the climate change scenarios.

## INTRODUCTION

### Goals and Rationale

- ❖ Estimate ancillary benefits: Assess and quantify the environmental benefit resulting from greenhouse gas mitigation.
- ❖ Provide policy recommendations for climate change and air quality programs: Help government officials and stakeholders understand the air pollution benefits of energy technologies that will reduce greenhouse gas emissions, thus the results of this analysis can enhance support for appropriate policy for UNFCCC and air quality control programs.

### Relationship to Other Related Studies

The first cost-benefit study of air quality control programs that applied the impact analysis approach was carried out by Joh (2000) for the Kyonggi area (a part of the Seoul Metro.) in 1999. Continuing to apply the impact analysis framework developed under ICAP, KEI is currently conducting a project funded by Korean Ministry of Environment targets to quantify the ancillary benefits of reduction of SO<sub>x</sub> and NO<sub>x</sub> at the national level. This project will last through August 2001.

### **Project Team**

For this ICAP project, the Korean team includes the following institutions and experts:

#### **Lead Institution: Korea Environment Institute (KEI)**

##### **Team Members:**

- ❖ Principal Investigator: Dr. Seunghun Joh, Korea Environment Institute (KEI)
- ❖ Energy and mitigation scenarios : KEI
- ❖ Air Quality: Dr. Sanggyu Shim, KIST
- ❖ Health Effects: Prof. Joohon Sung, College of Medicine, Kangwon National University
- ❖ Economic Valuation: Prof. Yeongcheol Shin, Daejin University

##### **International Collaboration:**

- ❖ Technical advice: National Renewable Energy Laboratory
- ❖ CVM: Dr. Alan Krupnick, Resources for the Future

## **METHODOLOGY**

Starting from GHG mitigation scenarios applied in the Seoul Metro, emission inventories and concentration levels for PM10 are estimated. Reductions in occurrences of premature mortality and morbidity of asthma and respiratory diseases are calculated based on concentration-response functions. Contingent valuation method (CVM) will be used to value premature mortality, however as the survey has yet to be completed, is benefit transfer estimates are employed to develop the initial estimates for this report. Cost of illness is applied for morbidity effects.

### **Key Scoping Decisions**

The following project scoping decisions were made through an initial project scoping workshop and further consultations with climate change, air pollution, health, and economic valuation experts.

- ❖ Area : Largely due to data availability, the metropolitan area(Seoul, Kyonggi, Inchon), was chosen which covers about a half of all Korean population (22 million out of 47 million, 46.5%)
- ❖ Time Period: 1995, 2000, 2010, 2020. Year 1995 plays the role of base year and 2010 and 2020 were selected to consider the potential timing of GHG mitigation under the UNFCCC.
- ❖ Pollutants of Concern: PM10 was the only pollutant considered in this initial analysis. Here, only direct PM10 was considered and the effects of secondary PM10 such as sulfates and nitrates were excluded from the analysis. Ozone was not considered in this study, as the ozone pollution modeling/projection could not be supported.
- ❖ Economic Valuation Methods: A CVM survey to develop unit values for premature mortality was administrated only in Seoul because of cost restrictions.

### **Reference and GHG Reduction Scenarios**

**Reference Scenario:** National data from the Ministry of Commerce, Industry and Energy (MOCIE) (MOCIE 1998) were used to develop bottom-up estimates for energy consumption and GHG emissions through 2020. Table 1 shows the proportion of national energy consumption that

is covered by the study areas, with the three areas accounting for 24% of national total in energy consumption.

**Table 1. Comparison of National Energy Use with ICAP Study Areas**

	ICAP_Seoul	ICAP_Inchon	ICAP_Kyonggi	National
<b>Total (1000 TOE)</b>	11360.02	7642.67	17053.90	150222.2817
<b>ICAP/National (%)</b>	7.56	5.09	11.35	

**GHG Reduction Scenarios:** Four alternative scenarios were evaluated, including:

- ❖ Reduction Scenario 1 – Assumptions include a portfolio of energy efficiency measures for all major energy sub-sectors including introduction of high-efficiency facilities, replacement of fuels according to MOCIE, increasing efficiency of PM10 emission controls at industrial manufacturing facilities, and the use of CNG fueled buses (CNG fueled buses are assumed to replace commercial buses by 10% in 2000, 75% in 2005, and 100% to 2010)
- ❖ Reduction Scenario 2 – Assumes 5% reduction in energy use across economic sectors regardless of measures and the use of CNG fueled buses
- ❖ Reduction Scenario 3 – Assumes 10% reduction in energy use across economic sectors regardless of measures and the use of CNG fueled buses
- ❖ Reduction Scenario 4 – Assumes 15% reduction in energy use across economic sectors regardless of measures and the use of CNG fueled buses

Scenario 1 involves assumptions regarding an enhanced program for improved air quality control. Thus, we propose that reduction scenarios 2-4 be considered for analysis of GHG mitigation activities in this analysis. Scenario 1 applies additional levels of air pollution control for PM10. Also note that scenarios 2-4 do not involve any assumptions regarding additional efficiency of pollution control and that pollution control efficiency is held constant.

Table 2 provides the estimate levels of greenhouse gas emissions (in thousands of tons of carbon equivalent) for each of the scenarios.

**Table 2. GHG Emission Estimates for Each Scenario**

		1995		2000		2010		2020	
		1000TCE	(%)	1000TCE	(%)	1000TCE	(%)	1000TCE	(%)
<b>Nationwide</b>	<b>BAU</b>	102,132	100	117,539.97	100	160,349.34	100	188,323.12	100
<b>Metropolitan area</b>	<b>BAU</b>	28,036	27.45	31498.91	26.80	45023.43	28.08	56372.70	29.93
	<b>Control</b>	28,036	27.45	30963.45	26.34	42976.20	26.80	52113.75	27.67
	<b>5% Reduction</b>			29923.97	25.46	42772.25	26.67	53554.06	28.44
	<b>10% Reduction</b>			28349.02	24.12	40521.08	25.27	50735.43	26.94
	<b>15% Reduction</b>			26774.08	22.78	38269.91	23.87	47916.79	25.44

### **Air Pollution Analysis**

The target region for the analysis is the Seoul Metropolitan Area, which includes Seoul, Inchon, and most part of Kyonggi Province. Only primary TSP and PM10 (not secondary particulates) from fuel combustion and fugitive dusts from paved roads are considered. Emissions are calculated with emission factors and activity data for each economic sector relying on fuel consumption data for the sectors and data on vehicle use. The atmospheric PM<sub>10</sub> concentrations

are calculated with the UR-BAT model, which is a revised urban scale version of ATMOS used in RAINS-Asia, with emission inventory and meteorological data compiled in this study.

Key assumptions include:

- ❖ The background atmospheric concentration of PM10 is assumed as 20ug/m<sup>3</sup>
- ❖ The number of registered vehicles in a domain is calculated based on the assumption that there will be the growth rate of oil price of 4% and low economic growth rate of 2% every year.
- ❖ The same meteorological input data of 1995 are used for other future years.
- ❖ Relative patterns of energy use in each region of analysis do not change from 2000 to 2020 for any reason other than the impact of energy policies in the reduction scenarios

It is important to note that in Korea, PM10 has been measured only since 1995 (20 sites in study area). This relative short history and sparse networks make it difficult to precisely assess the health effects from PM10 pollution. There are only a few studies evaluating the health effect from PM10 to date in Korea, although a growing body of evidence is being established about the health effects of TSP. For this analysis, we started with the ambient concentration and monitoring system for PM10 and focused on PM10 data since 1996, which is considered the most reliable.

### **Health Effects Analysis**

The health effects analysis evaluates impacts of changes in PM10 concentrations on the following health effects end points:

- ❖ Mortality: cardiovascular mortality and respiratory mortality. Baseline data was taken from the death registry data for all Korean people between 1996-1998 (Korean National Statistical Office)
- ❖ Morbidity: Asthma, Chronic Obstructive Pulmonary Diseases / Other aggravation of respiratory function and symptoms. Baseline data was taken from the Nationwide Health Insurance data (KNHI) between 1996-1998 for asthma and chronic obstructive pulmonary diseases (COPD).

A Robust Poisson Regression Model was used to fit the daily count of health outcomes on air pollution levels (PM10). Meteorological factors (average temperature and relative humidity), time trends, days of week, seasonal variations, and other related factors were considered.

### **Economic Valuation**

For the economic valuation of the effects, the Contingent Valuation Method (CVM) analysis has been proposed to estimate the unit value of premature mortality risk reductions. The Cost of Illness approach is applied for estimating the total medical cost of asthma and respiratory diseases. CVM will be carried out for the project with the cooperation of Dr. Alan Krupnick at RFF (Resources for the Future). KEI and RFF are carrying out a joint study of Willingness to Pay for premature mortality due to PM10 in Korea utilizing a Korean version of a questionnaire applied in a Canada study. The preliminary results of the CVM study will be available in the final report of this project due to be completed by the end of November 2000.

For this analysis (since the CVM methods have not been fully developed), mortality and morbidity reductions are valued using data on the Value of Statistical Lives (VSAL) based on Krupnick (2000) and U.S. EPA (1997, 1999). Applying the benefit transfer three values are

suggested: Low, central, and average (Table 8). Low and Central draws on Krupnick and High on EPA. With these three values, we took adjustment process based on per GDP and per purchasing power parity (PPP). With the results of no-adjustment along with the two adjusted values we derived one average number 1.4 million US dollars applied to the analysis.

Cost of Illness has been estimated in the following way.

Total medical cost of outpatient treatment = personal expenses for treatment + insurance reimbursement + traffic expenses + an estimate of the value of the waiting time for treatment

Total medical cost of inpatient treatment = personal expenses for hospital treatment + insurance reimbursement + expenses for travel + expenses for nursing + other supplementary expenses + an estimate of the value of time for the treatment period.

### **SCHEDULE OF KEY ACTIVITIES**

Tables 3 and 4 describe the schedule of key project activities:

**Table 3. Past Activities of Korea-ICAP**

<b>Date</b>	<b>Activities</b>
Feb. 1999	Scoping meeting in Korea
Aug. 1999	Contract made between Korea and NREL
Mar. 2000	IPCC Expert Workshop on Assessing The Ancillary Benefits and Costs of Greenhouse Gas Mitigation Strategies (Washington, DC)
Sep. 2000	Final report on Health Effects
Oct. 2000	Policymaker review workshop (Seoul, Korea)

**Table 4. Planned Activities of Korea-ICAP**

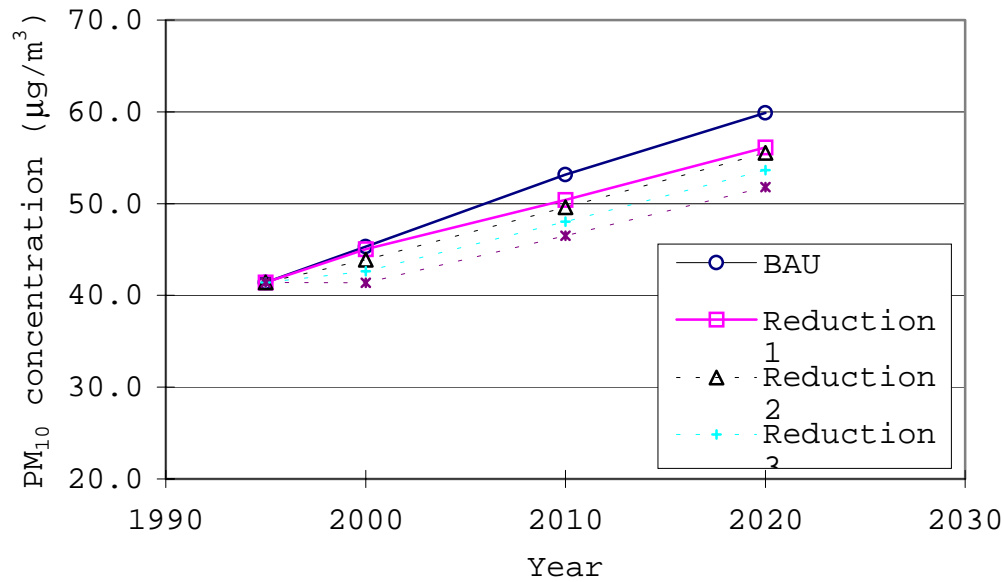
<b>Date</b>	<b>Activities</b>
Nov. 2000	COP6 Side-Event presenting results to policymakers
Nov. 2000	Updating draft Report
Nov. 2000	Final Synthesis Report of Project

## ANALYTIC RESULTS

### Air Pollution Emission and Atmospheric Concentration Levels

PM10 emission reductions for four GHG mitigation scenarios range from 20,000 to 30,000 tons/yr. in 2020 (off of a forecasted baseline of 140,000 tons/yr in 2020). Figure 1 depicts changes in atmospheric concentration levels for PM10 for a typical grid cell.

**Figure 1. Average Annual Atmospheric PM<sub>10</sub> Concentration by Scenarios at (col8, row7)**



Most of the PM10 reductions for the GHG mitigation scenarios (scenarios 2-4) come from transportation sector and paved roads (Table 5). This reflects the effect of energy efficiency measures and the switching to CNG buses which have a significant impact on emissions from the transportation sector. Table 6 illustrates GHG abated from the scenarios implemented.

**Table 5 Reduction of PM<sub>10</sub> Emission by Sectors for Reduction Scenario 1**

Year	Households	Commercial-Public	Industry (Manufacturing)	Transportation	Conversion	Paved roads	Sum
1995	0	0	0	0	0	0	0
2000	11	0	907	423	54	0	1397
2010	37	7	5832	6010	102	0	11988
2020	57	11	9920	7747	112	0	17845

**Table 5 Reduction of PM<sub>10</sub> Emission by Sectors for Reduction Scenario 2**

Year	Households	Commercial-Public	Industry (Manufacturing)	Transportation	Conversion	Paved roads	Sum
1995	0	0	0	0	0	0	0
2000	42	21	1376	1713	11	1857	5021
2010	36	24	1464	7491	12	2460	11486
2020	38	27	1531	9446	11	2959	14011

**Table 5 Reduction of PM<sub>10</sub> Emission by Sectors for Reduction Scenario 3**

Year	Households	Commercial-Public	Industry (Manufacturing)	Transportation	Conversion	Paved roads	Sum
1995	0	0	0	0	0	0	0
2000	83	42	2752	3009	22	3715	9624
2010	72	47	2928	9049	24	4919	17039
2020	76	53	3061	11403	22	5918	20534

**Table 5 Reduction of PM<sub>10</sub> Emission by Sectors for Reduction Scenario 4**

Year	Households	Commercial-Public	Industry (Manufacturing)	Transportation	Conversion	Paved roads	Sum
1995	0	0	0	0	0	0	0
2000	125	63	4128	4305	33	5572	14227
2010	108	71	4392	10606	36	7379	22591
2020	114	80	4592	13360	32	8877	27056

**Table 6 Reduction of GHG Emission by Scenarios**

	<i>GHG Abated</i>		<i>unit: 1000TCE</i>	
		2000	2010	2020
<b>Scenario1</b>	Control	535.5	2047.2	4259.0
<b>Scenario2</b>	5% Reduction	1574.9	2251.2	2818.6
<b>Scenario3</b>	10% Reduction	3149.9	4502.4	5637.3
<b>Scenario4</b>	15% Reduction	4724.8	6753.5	8455.9

**Health Effects**

The four GHG reduction scenarios result in notable decreases in mortality and occurrences of asthma and other respiratory diseases. Key results from the health effects analysis include:

- ❖ The decreases in premature deaths range from 40 deaths/yr for scenario 2 to 120 deaths/yr. in scenario 4 in 2020.
- ❖ The reductions in asthma and respiratory diseases range from 2800 occurrences/yr. to over 8300 occurrences/yr. in 2020.

Further results are depicted in Table 7.

**Table 7 Decreases in Annual Mortality and Morbidity Under GHG Reduction Scenarios**

		2000	2010	2020
<b>Scenario 1</b>	Mortality by Asthma	6.22	55.46	83.37
	Mortality by Respiratory	0.71	6.36	9.56
	Asthma	471.54	4,207.48	6,324.48
	Respiratory Diseases	9.59	85.57	128.63
<b>Scenario 2</b>	Mortality by Asthma	22.27	29.16	36.01
	Mortality by Respiratory	2.55	3.34	4.13
	Asthma	1,689.71	2,212.28	2,731.60
	Respiratory Diseases	34.37	44.99	55.56
<b>Scenario 3</b>	Mortality by Asthma	44.55	58.32	72.01
	Mortality by Respiratory	5.11	6.69	8.26
	Asthma	3,379.43	4,424.56	5,463.21
	Respiratory Diseases	68.73	89.99	111.11
<b>Scenario 4</b>	Mortality by Asthma	66.82	87.48	108.02
	Mortality by Respiratory	7.66	10.03	12.39
	Asthma	5,069.14	6,636.84	8,194.81
	Respiratory Diseases	103.10	134.98	166.67

### **Economic Valuation of Health Effects**

A range of values of statistical lives is used to calculate the value of the avoided premature deaths (see Table 8). Using these values of statistical lives and Cost of Illness calculations for the avoided cases of asthma and other respiratory diseases, these health benefits are monetized. Key results of this economic valuation include:

- ❖ The economic value of the deaths avoided from the climate change mitigation scenarios ranges from 36 million (2000, scenario 2) to 174 million (2020, scenario 4) US\$/yr. (Table 9).
- ❖ The economic value of the cases of asthma and other respiratory diseases avoided for the climate change mitigation scenarios range from 0.9 (2000, scenario 2) million to 4.4 million (2020, scenario 4) US\$/yr. (Table 9).
- ❖ The economic benefits per GHG emission avoided range from \$10 (2020, adjusted with per GDP) to \$42 (2000, no adjustment) for the climate change scenarios (Table 10).
- ❖ The cumulative value of these avoided health effects is estimated to range from 10(scenario 2, coi1) to 125(scenario 4, coi3) million US\$/yr (Table 11).



**Table 8 Transferred Monetary Value of Statistical Life**

	Value in the U.S. or Canada	Adjusted per GDP	Adjusted per PPP	Non adjusted
<b>Low</b>	1.3 M(1999 Ca.\$)	246.1	429.5	925.1
<b>Central</b>	3.8 M(1999 Ca.\$)	779.2	1360.0	2929.6
<b>High</b>	4.8 M(1990 US \$)	1288.7	1901.7	5066.6
<b>Average</b>		771.3	1230.4	2973.8

\*1999 present values, 1US\$=1,147 Korean Won (KW)

**Table 9 Estimated Annual Health Benefits of Mortality and Morbidity Avoided**

(99 million US \$)	Benefits from decreases of	2000	2010	2020
<b>Scenario 1</b>	Asthma and respiratory disease	0.3	2.3	3.4
	Premature deaths	10.0	89.5	134.5
	Total benefit	10.3	91.7	137.9
<b>Scenario 2</b>	Asthma and respiratory disease	0.9	1.2	1.5
	Premature deaths	35.9	47.0	58.1
	Total benefit	36.8	48.2	59.6
<b>Scenario 3</b>	Asthma and respiratory disease	1.8	2.4	3.0
	Premature deaths	71.9	94.1	116.2
	Total benefit	73.7	96.5	119.1
<b>Scenario 4</b>	Asthma and respiratory disease	2.8	3.6	4.4
	Premature deaths	107.8	141.1	174.3
	Total benefit	110.5	144.7	178.7

\*1999 present values, 1US\$=1,147 Korean Won (KW)

**Table 10 Economic Benefit Per GHG Emission Avoided**

Economic values in \$/ton Of carbon avoided	2000	2010	2020
Adjustment per GDP	11.2	10.3	10.1
Adjustment per PPP	17.5	16.0	15.8
No adjustment	41.5	38.0	37.5
Average	23.4	21.4	21.1

\*1999 present values, 1US\$=1,147 Korean Won (KW)

**Table 11 Cumulative Results 2000 to 2020 of Total Excess Occurrence of Mortality and Morbidity Avoided and the Corresponding Benefits**

		Occurrence	Benefit		
			100M KW	1M US \$	per year(\$)
<b>Scenario 2</b>	coi1	45778.81	2331.1	203.2345	10.16173
	coi2		6914.9	602.8684	30.14342
	coi3		9598	836.7916	41.83958
<b>Scenario 3</b>	coi1	91557.61	4662.3	406.4778	20.32389
	coi2		13829.8	1205.737	60.28684
	coi3		19196	1673.583	83.67916
<b>Scenario 4</b>	coi1	137336.4	6993.4	609.7123	30.48561
	coi2		20744.7	1808.605	90.43025
	coi3		28793.9	2510.366	125.5183

\*1999 present values with annual discounting rate of 7.5%, 1US\$=1,147 Korean Won (KW)

\*coi1: Wages per hour of respondents without occupation equal to zero.

coi2: If she is housekeeper, her wage per hour equals to the average wage of unskilled labors in 1995

coi3: Wages of respondent without occupation equals to those of the employed with the identical qualifications such as education, age, etc.

## POLICY IMPLICATIONS AND CONCLUSIONS

A review meeting for the ICAP-Korea project was held on 16 October 2000. This meeting was attended by the Korean ICAP study team lead by KEI, Korean policy makers from Ministry of Environment and the Korean legislature, Korean technical experts, and technical experts from the USA. The objectives of the meeting were to present the analytical methodology and the outcome of the project to Korean policy makers and technical experts and to obtain feedback on the usefulness of the project approach and results for enhancing effective policy making in Korea in the areas of GHG mitigation and air quality management.

The ICAP-Korea assessment found that the ancillary benefits of implementing GHG mitigation measures in Seoul Metro. Korea between 2000 and 2020 would, on average, result in human health benefits of reduced air pollution of \$US10-42/ton C mitigated, a significant figure when considering the costs of potential GHG mitigation measures. Policy makers agreed that the ICAP approach and the results of this project were useful in informing policy makers and the public of the co-benefit impacts of policy decisions and assisting with the development of cost-effective integrated strategies to address both local air quality issues and GHG mitigation concerns simultaneously.

### Study Limitations that Affect Magnitude of Results

The average ancillary health benefits of \$US10-42/ ton C were viewed as conservative due to several limitations of the current studies analytical approach and methodology which tended to lead to underestimates of the total benefits which could be realized. The meeting recognized these study limitations and concluded that if these limitations could be successfully addressed in future work, the expected ancillary benefits of the GHG mitigation scenarios would likely increase. The discussion of the key limitations identified by the policy makers and experts and their effect on the assessment outcome is summarized below.

### **Mitigation Scenarios**

The meeting noted that the GHG mitigation scenarios assumed a modest level of implementation of effective GHG mitigation measures and that these measures were not specifically targeted toward “integrated strategies” which would be most effective in simultaneously reducing GHG emissions and emissions of air pollutants. A greater focus in the mitigation scenarios on harmonized strategies that target both GHG and air pollution emissions from specific sectors and fuel types would likely have resulted in greater emission reductions of both types of pollutants, and hence greater health benefits.

### **Assessment Considered a Limited Set of Key Air Pollutants**

The only air pollutant considered under the assessment methodology was directly emitted PM10, which Korean researchers estimate make up only about 50% of total air pollution health effects in Seoul. Other pollutants which have been determined to have important impacts on human health include fine particulate matter (PM2.5 and secondary particulate matter such as sulfates and nitrates), SO2, NOx, and O3. Atmospheric concentrations of these other pollutants would also be expected to decline as a result of implementation of the GHG mitigation strategies, along side PM10. Thus, the meeting recognized that consideration of a wider range of air pollutants would allow the project to quantify an increasingly larger set of ancillary health benefits resulting from implementation of GHG mitigation measures.

### **Health Effects Relationships May Underestimate Actual Impacts**

First, health effects are correlated with daily average rather than daily peak air pollutant concentrations. Air quality modeling for this study provided estimates of future PM10 levels as average daily concentrations. Monitored daily average concentrations of PM10 in Seoul are often 3-5 times lower than monitored daily peak concentrations. Lower variability of the daily average concentration levels as compared to daily peak PM10 concentrations results in poorer correlation with observed health effects. Thus, the resulting dose-response functions do not capture the full impacts of increasing PM10 concentrations. As a result, the meeting concluded that the assessment, by correlating health effects with daily average PM10 concentrations, underestimated the health impacts resulting from increased PM10 concentrations and hence the ancillary benefits of reducing these concentrations were also underestimated.

Second, hospital and insurance record data used to determine the magnitude of health effects underestimates the actual number of individuals effected by an air pollution episode. It is widely accepted that many acute respiratory cases are treated at home by individuals with over-the-counter drugs available from pharmacies and are not treated by medical staff and hence do not appear on hospital or insurance record logs. Under representing the magnitude of the effect on public health of air pollution episodes, results in dose-response functions that underestimate possible health impacts from increasing levels of air pollution and hence underestimate potential ancillary benefits of GHG mitigation scenarios.

### **Relevance and Usefulness of the ICAP Approach and Results for Policy Making**

There was an overwhelming consensus that the approach and results of this project were very useful for policy making at both local levels (on air quality management) and national levels (on GHG mitigation). Policymakers noted that the project demonstrated the potential for real, positive economic and social ancillary benefits from mitigation scenarios and commended the project efforts activities to provide these estimates. An important next step in this process would be to disseminate more widely the outcome and results of this project to achieve greater recognition and understanding of the results in the policy making community and the general public.

Representatives from the Ministry of the Environment (MOE) noted that while in general in Korea, policy makers place greater value on actions to improve local air quality than on actions to mitigate GHG emissions, the approach followed in this project could be used to develop cost-effective integrated strategies to address both types of concerns simultaneously.

The representative from the Legislature pointed out that the Korean government already expressed a keen interest in climate change issues and lawmakers are very interested in the issue of ancillary benefits of climate change mitigation actions. Under consideration is establishment of a special committee on climate change in congress to investigate policy matters related to climate change issues in greater detail. However, the problem of awareness extends beyond the policymakers to the general population who view climate change as a complicated, difficult and potentially costly problem. Thus, one benefit of this project and its results would be to assist with educating the general public about the potential economic and social benefits of taking action on climate change issues in a way that allows them to better relate to these issues on a personal level and comprehend the costs and benefits of policy decisions.

The ICAP project affords the benefit of allowing the policy issues of climate change to be viewed in the context of sustainable development. Through linking strategies to address local air quality and improve human health with GHG emissions reductions, the relationship between sustainable development and climate change policy becomes more apparent. As those linkages are further developed, it becomes clear that practical measures to address climate change are also practical measures to help achieve sustainable development goals as well.

It was also pointed out that in Korea, as in the US and many other developed countries, pollution regulation has traditionally addressed one criteria pollutant at a time often resulting in a overall regulatory strategy which is not optimal. The ICAP project is useful for air pollution regulation in Korea as it aids policymakers in integrating the regulation of multiple pollutants simultaneously, resulting in more effective, and more cost-effective strategies.

The policy makers also noted that to be useful in practical application, the ICAP project should attempt to prioritize specific measures and strategies in terms of their benefit potential and cost effectiveness in achieving simultaneous GHG mitigation and human health improvement. To address this concern, ICAP would need to develop and analyze more specific mitigation measures and technologies related to specific sectors and fuel types to determine the overall impact and benefit ratio for these measures. In this way, the ICAP approach could more effectively communicate to policymakers and the general public the anticipated level of ancillary benefits of specific measures and build support for implementation of these measures.

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